

Claims

1. A filtration device comprising a web of material that itself comprises a layer of filtration material, the web material having first and second major surfaces and an opening, and at least one component that is attached to the web material, the component comprising a component base portion having a surface that abuts against the first major surface of the web material and an extension member that extends from the component base portion and passes through the opening of the web material, the extension member also having a deformed portion that is turned back toward the component base portion and has at least a surface part thereof that is positioned against the second major surface of the web material so as to clamp the component in fluid-tight relationship to the web material.

2. The filtration device of claim 1, wherein the surface part of the deformed portion abuts against the second major surface all the way about the opening that is provided through the web material so as to effectively create a sealed attachment between the component and the web material.

3. The filtration device of claim 2, wherein the extension member comprises a portion extending from the component base portion and the deformed portion, the deformed portion comprises a first portion extending back toward the component base portion and that has an end that is positioned over a peripheral zone of the second major surface of the web material, and a surface part of the deformed portion that abuts against the second major surface of the web material is provided on the end of the first portion of the deformed portion, whereby the peripheral zone of the web material is compressed and thus clamped between the end of the first portion and the component base portion.

4. The filtration device of claim 3, wherein the extension member is round as viewed in a transverse cross-section taken through the portion of the extension member that extends from the component base portion.

5. The filtration device of claim 4, further including means for restricting rotation of the component relative to the web material, the means being provided to act between the web material and one of its interfaces with the base portion and the surface part of the deformed portion that abuts against the second major surface of the web material.

6. The filtration device of claim 5, wherein the means for restricting rotation comprises adhesive.

7. The filtration device of claim 3, wherein some of the peripheral zone of web material is also provided between the portion of the extension member that extends from the component base portion and the first portion of the deformed portion.

8. The filtration device of claim 3, wherein the deformed portion further comprises a second portion provided at the end of the first portion and that extends a distance away from the first portion over a peripheral zone of the second major surface of the web material, and a surface part of the deformed portion that abuts against the second major surface of the web material is provided on the second portion of the deformed portion, whereby the peripheral zone of the web material is compressed and thus clamped between the second portion and the component base portion.

9. The filtration device of claim 8, wherein some of the peripheral zone of web material is also provided between the portion of the extension member that extends from the component base portion and the first portion of the deformed portion.

10. The filtration device of claim 8, wherein the portion of the extension member that extends from the component base portion is thicker in its transverse cross-section than the deformed portion.

11. The filtration device of claim 10, wherein the portion of the extension member that extends from the component base portion further includes a protrusion that extends along it and also engages the peripheral zone of the web material.

12. The filtration device of claim **10**, wherein the deformed portion decreases in its thickness in transverse cross-section as it extends toward its end.

13. The filtration device of claim **10**, wherein the deformed portion includes a thinned area extending along it at a location of a bend provided therein

14. The filtration device of claim **13**, wherein the deformed portion includes plural thinned areas extending along it, including a first thinned area at a location of a bend that is provided where the deformed portion of the extension member is turned back toward the component base portion and a second thinned area at a location of a bend between the first and second portions of the deformed portion.

15. The filtration device of claim 1, wherein the web material comprises a plurality of layers of material including at least one layer of filtration material.

16. The filtration device of claim 1, wherein the web material comprises a mask body of a respiratory mask.

17. The filtration device of claim **16**, wherein the component comprises at least a part of an exhalation valve that includes an opening provided through the extension member.

18. The filtration device of claim **17**, wherein the web material comprises a plurality of layers with a first layer forming the first major surface being a spun bond material.

19. The filtration device of claim **18**, in which the spun bond material is a polypropylene spun bond material, and the component base portion and its extension member are formed from polypropylene.

20. The filtration device of claim **16**, wherein the mask body includes structurally defined fold lines making it capable of being folded flat for storage and, during use, being

capable of forming a cup-shaped zone over a mouth and nose of a wearer.

21. A method of attaching a component to a web of material comprising filtration material, the method comprising the steps of:

providing a web comprising a layer of filtration material, the web having first and second major surfaces and an opening provided through it;

providing a component that comprises a component base portion and a deformable extension member that extends from the base to a tip;

inserting the extension member tip first through the opening in the web material and contacting a surface of the component base portion against the first major surface of the web material with the extension member extending through the opening; and then deforming the extension member back toward the component base portion so that at least a surface of the extension member abuts against the second major surface of the web material and, along with the contact of the surface of the component base portion and the first major surface of the web material, clamps the component in fluid-tight relationship to the web material.

22. The method of claim 21, wherein the step of providing web material comprises the provision of a multi-layer web material comprising at least one layer of filtration material.

23. The method of claim 21, wherein the step of providing a component includes loading the component onto a die of a cooperating punch and die system and supporting at least a portion of the component base portion by an anvil portion of the die.

24. The method of claim 23, wherein the step of inserting the extension member of the component through the opening of the web material is conducted after the component is loaded on the die and includes moving the web material and die relative to one another until a surface of the component base portion abuts the first major surface of the web material.

25. The method of claim **23**, wherein the step of deforming the extension member of the component back toward the component base portion comprises advancing a punch assembly relative to the web material after the component is inserted in position and deforming the extension member by contact of the extension member with the advancing punch assembly, whereby the punch assembly bends a deformed portion of the extension member relative to a non-deformed portion of the extension member so that its tip is moved closer to the second major surface of the web material.

28. The method of claim **25**, wherein the step of deforming the extension member of the component back toward the component base portion further comprises a second deforming step for bending the deformed portion of the extension member into a first portion that extends toward the web material and a second portion of the deformed portion that extends for a distance over the second surface of the web material.

27. The method of claim **25**, wherein the step of deforming the extension member of the component back toward the component base portion is conducted by selectively advancing inner and outer punches of the punch assembly so that an initial deformation is performed by advancing the inner punch to define a first bend between the deformed and non-deformed portions of the extension member while the tip of the extension member is moved toward the second major surface of the web material, and a second deformation is performed by advancing the outer punch relative to a stationary inner punch after the initial deformation so as to move the tip of the extension member closer to the second major surface of the web material and to abut a surface of the extension member against the second major surface of the web material.

28. The method of claim **27**, wherein the second deformation also produces a second bend between a first portion of the deformed portion that extends toward the web material and a second portion of the deformed portion that extends for a distance over the second surface of the web material.

29. The method of claim 21, wherein the step of deforming the extension member back toward the component base portion includes controlling the deformation so that the surface of the extension member that abuts against the second major surface of the web material and the surface of the component base portion that contacts the first major surface of the web material are closer to each other than the thickness of the web material so as to compress the web material and thereby facilitate clamping of the component in fluid-tight relationship to the web material.

30. The method of claim 21, further including a step of providing a seal enhancing substance between at least one of the interface between the surface of the extension member and the second major surface of the web material and the interface between the surface of the component base portion and the first major surface of the web material so as to facilitate making a fluid-tight relationship of the component to the web material.

31. The method of claim 21, wherein the web material comprises a mask body of a respiratory mask, the opening is provided through the mask body, and the component is attached to the mask body.

32. The method of claim 21, wherein the step of deforming the extension member back toward the component base portion is conducted as a cold forming process.

33. The method of claim 21, wherein the step of deforming the extension member back toward the component base portion is conducted as a thermal forming process including a step of introducing a sufficient quantity of heat to the extension member of the component prior to the deforming step so as to permit the extension member to be deformed under process conditions that would otherwise not be suitable to perform the deforming step.

34. A method of making a respiratory mask, wherein a component is attached to a mask body, the method comprising the steps of:

providing a mask body comprising a layer of filtration material, the mask body having first and second major surfaces and an opening provided through it;

providing a component that comprises a component base portion and a deformable extension member that extends from the base to a tip;

inserting the extension member tip first through the opening in the mask body and contacting a surface of the component base portion against the first major surface of the mask body with the extension member extending through the opening; and then deforming the extension member back toward the component base portion so that at least a surface of the extension member abuts against the second major surface of the mask body and, along with the contact of the surface of the component base portion and the first major surface of the mask body, clamps the component in fluid-tight relationship to the mask body.

35. The method of claim 34, further including a step of molding a piece of web material comprising at least one layer of filtration material into a shaped mask body for a respiratory mask of a shape that will create an open volume about at least a part of a wearer's face.

36. The method of claim 35, wherein the molding step is conducted prior to attaching the component to the mask body.

37. The method of claim 35, wherein the component comprises at least a part of an exhalation valve that is attached to the molded mask body.

38. The method of claim 34, further including a step of converting web material that comprises at least one layer of filtration material into a foldable respiratory mask that can be folded into a flat state and unfolded to form a shape that will create an open volume about at least a part of a wearer's face.

39. The method of claim 34, wherein the step of deforming the extension member back toward the component base portion is conducted as a cold forming process.

40. The method of claim 34, wherein the step of deforming the extension member back toward the component base portion is conducted as a thermal forming process including a step of introducing a sufficient quantity of heat to the extension member of the component prior to the deforming step so as to permit the extension member to be deformed under process conditions that would otherwise not be suitable to perform the deforming step.

41. An inline method of making plural foldable respiratory masks that can be folded into a flat state and unfolded to form a shape that will create an open volume about at least a part of a wearer's face, the method including the steps of providing a web material comprising a layer of filtration material, performing a number of sequential forming operations for converting the web material into a series of foldable respiratory masks, and attaching a component to each respiratory mask, the method of attaching each one of plural components to a plurality of respiratory masks comprising the steps of:

providing an opening through a mask body from a first major surface to a second major surface thereof;

providing a component comprising a component base portion and a deformable extension member that extends from the base to a tip;

inserting the extension member of the component, tip first, through an opening in the mask body and contacting a surface of the component base portion against the first major surface of the mask body with the extension member extending through the opening;

and then

deforming the extension member back toward the component base portion so that at least a surface of the extension member abuts against the second major surface of the mask body and, along with the contact of the surface of the component base portion and the first major surface of the mask body, clamps the component in fluid-tight relationship to the mask body.

42. The method of claim 41, wherein the step of deforming the extension member back toward the component base portion is conducted as a cold forming process.

43. The method of claim 42, wherein the step of deforming the extension member back toward the component base portion is conducted as a thermal forming process including a step of introducing a sufficient quantity of heat to the extension member of the component prior to the deforming step so as to permit the extension member to be deformed under process conditions that would otherwise not be suitable to perform the deforming step.